Science education in Canada

Background Paper BP-265E

SCIENCE EDUCATION IN CANADA

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August 1991

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Cat. No. YM32-2-265E

ISBN 0-660-14518-9

CE DOCUMENT EST AUSSI PUBLIÉ EN FRANÇAIS

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INTRODUCTION

The importance of science and technology in society has grown enormously over the past two decades and, in an increasingly technological world, has affected most facets of our lives. There remain few aspects of society that have not been radically altered by changes in technology, which have been occurring at a particularly rapid pace over the last 20 years and will likely accelerate in the future.

The Canadian economy is strongly influenced by these scientific and technological advances. As globalization becomes a reality, it has become clear that Canada must remain in the forefront of technological innovation in the workplace in order to become and to remain competitive. To do this, Canada must have a scientifically and technologically literate workforce, trained both to work with sophisticated equipment and to develop new technologies. Science education, beginning at an early age, is essential in order to achieve this.

The importance of strengthening Canada's educational system is increasingly recognized by politicians, policy-makers and the general public. As stated in the May 1991 Speech from the Throne, "Canada's ability to prosper in a global economy will be determined by the level of Canadians' educational achievement ..."(1) As the next century approaches, the link between Canadians' education and their competitiveness becomes increasingly apparent.

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(1) Speech from the Throne to Open the Third Session Thirty-Fourth Parliament of Canada, 13 May 1991.

Significant problems exist, however, in science education in Canada. Not enough Canadians are choosing to pursue careers in areas requiring scientific and technological training. The resulting shortage of scientists and engineers, technologists and technicians will soon become critical. At the same time, the average Canadian displays an appalling lack of understanding of even the most basic scientific concepts. This paper will examine the present situation of science education in Canada and look at means by which it can be improved.

CANADIANS AND SCIENCE

At the end of 1989, Dr. Edna Einsiedel of the University of Calgary conducted a survey to determine Canadians' basic scientific knowledge and their attitudes towards science. The results of this survey were shocking. Nearly two-thirds of the people questioned could not name a single Canadian scientist, while over half did not know of any Canadian scientific achievements. Basic scientific knowledge was not much more impressive; half the respondents were unaware that the earth takes a year to go around the sun and nearly half believed that boiling radioactive milk makes it safe to drink.(2)

Although the survey did highlight a dismal lack of knowledge about science and technology, with women scoring even worse than men, it also indicated that most Canadians see science as a positive force in their daily lives and believe it should receive more support from government. The majority claimed to be very interested in media stories about science and technology, especially on health-related issues.(3) This interest

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(2) Christine Tausig, "Science Survey Scores Low, Interest High," *University Affairs*, April 1990, p. 3.

(3) *Ibid.*

is, unfortunately, not apparent in younger Canadians, who are at the age when decisions about careers in science and technology are made. Furthermore, despite the apparent interest of some Canadians in science, studies indicate that there are serious problems in Canada's science education system.

SCIENCE EDUCATION

In 1990, the Economic Council of Canada published a Working Paper entitled: *Science Achievement in Canadian Schools: National and International Comparisons.* This paper analyzed science education in Canada with the aim of improving the methods employed and the levels attained.(4)

The report highlighted the fact that the "essential characteristic of education in Canada" is the "exclusive jurisdiction of the provinces over education, and the inherent diversity which this creates..."(5) This makes it very difficult to obtain a coherent picture of science education in Canada. Nevertheless, the report outlined a number of important findings.

In Canada's grade schools, there are few similarities in the science curricula offered across the country. This gradually changes in the higher grades, where programs differ only slightly from province to province. At the elementary level, no specific science training is required for the teachers but their degree of specialization increases with the grade level. Finally, female teachers tend to dominate at the primary grade level while at the secondary school level most of the teachers are male.(6)

These findings reinforce many of the criticisms made of the Canadian education system. With little specific science training required

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(4) Robert K. Crocker, *Science Achievement in Canadian Schools: National and International Comparisons,* Economic Council of Canada, 1990.

(5) *Ibid.*, p. 51.

(6) *Ibid.*, p. 51.

of teachers of the lower grades there is a danger that many children will lose interest in the subject at a young age. Although the high proportion of women teachers at the primary level can provide girls with role models, many of these women may themselves have rejected science and may communicate their dislike and fear of the subject to their students. Finally, the lack of a common curriculum across the country suggests that science is taken less seriously at this level than at the secondary level. It is possible that this attitude can influence students' later decisions with regard to science programs.

When compared with students of other countries, interestingly, Canadian students ranked high in science knowledge at an elementary level; however, as the grades got higher our performance worsened. At the senior secondary level, Canada ranked near the bottom of the 14 participating countries. There are, however, problems in studies of different countries; groups of students examined for the study are not always comparable. For example, in Hong Kong the students at the senior secondary level are a select group, only a small proportion of whom are enrolled in science courses.(7)

Comparisons between Canada and other countries are also complicated by the fact that Canada comprises ten provinces and two territories, so that there are twelve different educational systems. The results of the comparative study indicated that western provinces tend to have higher science achievement scores, followed closely by Ontario. The lowest scores were in the eastern provinces. With so many systems in place it is difficult to make a firm statement about Canada's education system as a whole or to make effective changes to improve the country's standing.

SCIENCE FOR EVERY STUDENT

The Economic Council of Canada study discussed above was carried out in 1990 but it had long been recognized that there are faults in Canada's science education system. In 1984 the Science Council

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(7) *Ibid.*, p. 52

published a report discussing, in broad terms, the problems with the teaching of science in Canada and ways of solving them.

Entitled *Science for Every Student,* the Science Council report was the result of a four-year study into the science curriculum of every province and territory. The study investigated past and present science education in Canada with the aim of making recommendations for future directions.

Through its study, the Science Council reaffirmed the importance of every student's possessing a basic understanding of scientific and technological issues. It argued that "for Canada to cope with social changes rooted in highly specialized technologies, its citizens need the best *general* education possible -- an education comprising not only the traditional basics of language and mathematics, but also the *new* basics of our contemporary culture: science and technology."(8)

The report suggested that to achieve this goal, a school's curriculum should be devised with four broad aims in mind:

1. to encourage full participation in a technological society;
2. to enable further study in science and technology;
3. to facilitate entry to the world of work;
4. to promote intellectual and moral development of individuals.(9)

This report highlighted the problem of the large gap between what science education aims to achieve and what it actually accomplishes. In order to shrink that gap the Science Council recommended that science education be made accessible to all students and that women and high achievers be particularly encouraged to pursue it. The science curriculum itself should present a more authentic view of science with a greater emphasis on the connection between science and technology and everyday life. Scientific ideas should be presented in a Canadian context to

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(8) Science Council of Canada, *Science for Every Student,* Ottawa, 1984, p. 9.

(9) *Ibid.*, p. 10.

heighten interest in the subject. Finally, above all else, there should be a drive for high quality in science education.(10)

FUTURE SHORTAGES OF SCIENTISTS AND ENGINEERS

Science for Every Student was published in 1984 but little has changed in the intervening years, despite the fact that science and technology are just as important today, if not more so, to this country's future ability to compete. A lack of trained scientists and engineers could cause serious problems for the Canadian economy. A study published in 1989 by the Natural Sciences and Engineering Research Council of Canada (NSERC) outlined Canada's future need for scientists and engineers.

The study noted the recent decrease in Canada's 18-24 year old age group. This decrease is predicted to continue, reaching its nadir in 1997. Surprisingly, despite this drop in university-aged people, there is still an increase in the number of students enrolling for university degrees. Fewer students, however, are choosing to pursue degrees in science and engineering. This, the report argued, should be seen as a warning signal; it could easily lead to a future drop in the supply of trained scientists and engineers.(11)

This foreseen drop in supply coincides with an increasing need in both the industrial and university sectors for highly qualified scientists and engineers. Assuming that the Canadian economy will continue to experience growth over the next decade, the NSERC study argued that there will be an increasing demand from the business sector for scientists and engineers with postgraduate degrees. At the same time, it is expected that there will also be increased demand in the university sector for

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(10) *Ibid.*, p. 11.

(11) Robert Kavanagh, "The Future Supply of Highly Qualified Engineers and Scientists and the Role of NSERC," in *Canada's Future Requirements for Highly Qualified Scientists and Engineers*, 1989, p. 174-175.

scientists and engineers with doctoral degrees. This will largely be the result of retirements and deaths of current faculty members.(12)

The predicted increase in demand for scientists and engineers, coinciding with a decrease in supply, could cause serious problems for the Canadian economy over the next decade. Although NSERC has programs in place to encourage and provide financial assistance for students of science and engineering, it is recognized that the process of education in Canada takes place over a 20-year period. In order to ensure an adequate supply of highly qualified scientists and engineers for the future, children must be encouraged early to study science. This again places emphasis on improving science education throughout the entire educational system.

NSERC highlighted one group as deserving particular attention: women, who traditionally have not pursued careers in science and engineering. This problem, and possible ways of alleviating it, will be discussed in the next section.

WOMEN AND SCIENCE EDUCATION

An increasing recognition of the importance of science education has led to a closer examination of the presence of women in the world of science.Although women represent over 50% of the population and a continually growing proportion of the workforce overall, the percentage of women employed in scientific fields remains small. The growing recognition of a future shortage of scientists makes it imperative to encourage women to consider these career paths.

First, however, it is necessary to have an understanding of why women have traditionally shunned these fields. Although many questions remain, a number of studies have pointed to certain factors. Before schooling begins, most young girls are influenced by their parents and by

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(12) *Ibid.*, p. 186.

societal pressures away from scientific activities. Whether consciously or not, girls are often encouraged to play with dolls, for example, rather than with building blocks or toys like Lego. It is unclear how much this early socialization affects women's future career choices but any influence is often reinforced by school experience.(13)

As a female child progresses through the school system, many factors affect her decision on whether to pursue science courses. Lack of female role models, gender biases in classroom conduct and in curricular materials, and teacher's low expectations for girls can all discourage girls from studying mathematics and science. If they decide at an early age to drop mathematics and science courses, it is difficult for students to pursue these subjects later.

There are a number of ways in which the obstacles to women's careers in science can be overcome. It is vital that non-traditional areas be represented as feasible options and receptive to women students. This must be done at all levels of education, from high school, to university, to education for adults returning to formal education. A number of approaches are possible, including career days and workshops to outline options to high school students, summertime math and science career programs which might include laboratory activities, participation in research projects and visits to job sites, and visits by women enrolled in university science programs or pursuing a scientific career.

Efforts must also be made to make science programs more accessible to women. Bridging programs can be formulated to allow women to acquire the background needed to take science courses, and the structures must be in place to encourage women to enter and remain in such courses. Women who already have degrees in science but have left the field for any reason (for example, to take up family-related responsibilities) should be able to re-enter the workforce with the assistance of specially designed programs to help them review the latest developments in their field.

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(13) Council of Ontario Universities, *Attracting and Retaining Women Students for Science and Engineering,* Report from the Committee on the Status of Women in Ontario Universities, June 1988, p. 1.

Academic policies that are free of gender bias and allow for a flexibility in programs, and distance education can also help to make education accessible to women. Efforts should also be made to ensure that class scheduling allows for the responsibilities of raising a family. Financial assistance and scholarships aimed at women entering or returning to science programs will encourage women to pursue these studies. Finally, the atmosphere on the campus and within the various faculties should be supportive of women who pursue science programs.(14)

A number of programs already in place aim at encouraging women to pursue careers in science and engineering. Ryerson Polytechnical Institute in Toronto, for example, has established the Discover Engineering camp to encourage female high school students to consider careers in these areas. By allowing the students to perform different experiments, for example testing an airplane wing in an air tunnel, and by inviting women engineers to discuss the challenges of their fields, the program hopes that a greater number of women will choose to continue their studies at a university level.(15) Other programs are in place at various universities but there is a need for much more focus on grade school and high school students.

Programs such as those described above are good examples of first steps which should be taken to convince more women to study science and engineering. Many such efforts must be put in place if the final goal is to be achieved. Although factors that discourage girls from studying science can be identified, it is much more difficult to determine exactly what motivates girls to consider non-traditional careers. Perhaps the single most important factor is the influence of a role model. This suggests that, as more women choose careers in science, others will be encouraged to follow their example.

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(14) *Ibid.*, p. 507.

(15) "Scientific Summer Seduction," *Globe and Mail*, (Toronto), 16 July 1991.

CONCLUSION

There is little disagreement about the fact that a problem exists in science education in Canada; however it is difficult to determine the best solution. A number of approaches might prove useful.

A special effort must be made to train teachers at all levels in methods of teaching science. Particularly at the elementary school level, it is clear that not enough teachers have a strong knowledge of or enthusiasm for science. More emphasis can be placed upon science education in teachers' colleges, but programs should also be offered to teachers already in the school system. Programs can be implemented which bring working scientists into direct contact with teachers. By discussing new scientific ideas with the teachers and suggesting methods for introducing them into the classroom, scientists can greatly aid teachers in communicating enthusiasm for science to the students. Many experts believe that this type of close contact between scientists and teachers is the key to improving science education.(16)

Despite the jurisdictional problems that plague education reform in Canada, it should be possible to work toward common reforms at a national level. The government, in consultation with the 12 provincial and territorial governments, could consider establishing a National Centre for Science Education which could closely examine science education in this country and suggest ways to improve it. By consulting widely across the country and at different educational levels, this centre could respond positively to the many challenges confronting the country today.

It is clear that improving science education is crucial to the long term health of the Canadian economy. In a society where science and technology are pervasive, a knowledge of and facility with science is essential for all citizens. Science education must begin with a firm base in primary school but it must continue into secondary school, university

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(16) For further details on a program in place in the United States see "Scientists Educate the Science Educators," *Science,* 24 May 1991, p. 1061-1062.

and beyond. In this era of lifelong learning, Canadians must be ready and able to adapt themselves to new skills and technologies at many different points in their career. Without this ability, Canadians will have a great deal of difficulty in competing in the global economy.

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